FOOD AND FEEDING HABITS OF TREE FROGS IN OKOMU OIL PALM PLANTATION, OVIA SOUTH- WEST LOCAL GOVERNMENT, EDO STATE, NIGERIA.

BY

Isaac Chisom GODWIN

LSC1906339

DEPARTMENT OF ANIMAL AND ENVIRONMENTAL BIOLOGY

FACULTY OF LIFE SCIENCES

UNIVERSITY OF BENIN

BENIN CITY

NIGERIA.

SEPTEMBER, 2023

FOOD AND FEEDING HABITS OF TREE FROGS IN OKOMU OIL PALM PLANTATION, OVIA SOUTH- WEST LOCAL GOVERNMENT, EDO STATE, NIGERIA.

BY

Isaac Chisom GODWIN

LSC1906339

A DISSERTATION SUBMITTED TO THE DEPARTMENT OF ANIMAL AND ENVIRONMENTAL BIOLOGY, UNIVERSITY OF BENIN, BENIN CITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF SCIENCE B.Sc. (HONS) IN ANIMAL AND ENVIRONMENTAL BIOLOGY (PARASITOLOGY),

SEPTEMBER, 2023

CERTIFICATION

I certify that GODWIN Isaac Chisom with matriculation number, LSC1906339 carried out this project work under my supervision in the Department of Animal and Environmental Biology, University of Benin, Benin City.

_____ _____

Mrs. H.J. Ozemoka **Date**

Project supervisor

_____ _____

Prof. M.O. Omoigberale **Date**

Head of Department

_____ _____

External Supervisor **Date**

DEDICATION

This report is dedicated to my lovely parents Mr. and Mrs. Godwin Okoronkwo.

ACKNOWLEDGMENTS

My profound gratitude to God Almighty for His favor, mercies, grace, wisdom, strength and understanding

My deepest and profound gratitude goes to my supervisor, Mrs. H.J Ozemoka and Prof. M.S.O Aisien for their guidance, tutoring, mentoring and numerous advices during the course of this research. Also, to my course advisor, Dr. C.O Asemota for his fatherly advice and words of encouragement.

It is my honour to also appreciation my parents Mr. and Mrs. Godwin Okoronkwo for their constant encouragement, support, prayers and assistance throughout my academic and research period.

To my team mates, Joy, Racheal, Blessing, Jeffery, Rueben and others whose individual and collective contributions were helpful.

Thank you all.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

ABSTRACT

The stomach of 76 tree frogs belonging to one family (Hyperolidae), two genera (*Afrixalus* and *Hyperolius*) from the Okomu Oil Palm Plantation were examined for their food and feeding behaviour. The species examined included *Afrixalus dorsalis, Hyperolius concolor*, *H. fusciventris, H. fusciventris burtoni,* and *H. picturatus*. More males were collected than females and they accounted for 95% of the specimens collected. The stomach contents examined showed 20 individuals with empty stomachs, 23 with prey items and 33 stomachs with already digested prey items. The diet of the 5 species consisted of insects belonging to the order Hymenoptera, Coleoptera, Diptera, Orthoptera and members of the Araneidae. Hymenoptera constituted 16 .92% of the total prey items ingested by the tree frogs, followed by Diptera (7.69%), Coleoptera (6.15%), Araneida (4.62%) and Orthoptera (1.54%). Unidentified prey items and digested preys accounted for 12.31% and 50.77% respectively. Hymenoptera was a common diet among the *Hyperolius* species accounting for 75% of the prey items recovered from *H. concolor*, while Dipterans constituted a major portion (42%) of the prey items ingested by *Afrixalus dorsalis*. Although there were variations in feeding rate among these species, it was not statistically significant ($p>0.05$). The diet of the tree frogs in the plantation were a reflection of the prey items available rather than selective feeding.

CHAPTER ONE

1.0 INTRODUCTION

Amphibians are a diverse group of vertebrates which are in some ways an intermediate between the aquatic fishes and the terrestrial amniotes though they have not successfully attained full independence from water (Duellman and Trueb, 1994). In the transition from water to land, amphibians have developed adaptive mechanisms (lungs and skin for gaseous exchange) enabling them to alternate between land and water. Modern day amphibians (Lissamphibia) comprises of three orders namely; Anurans (frogs and toads), Caudata (salamanders), and Gymphiona (caecilians).

Amphibians species have a global distribution in nearly every continent with exception to Antartica and Green land. Frogs and toad are the most predominant groups, occurring in all land masses ranging from desert to rainforest, and from freshwater habitats to high mountains. However, they are dependent on the aquatic system for their breeding and the development of their tadpole. Amphibians are a major component of the ecosystem and the food chain both as predators and preys. Amphibians are very important as they serve as bio-indicators of environmental health, help in the recycling of nutrients in the soil, contribute to biodiversity and human well-being. Their sensitivity to the environment makes them valuable indicators of the ecosystems health. Their unique characteristics have led to various scientific discoveries and application in medicine, pharmacy and biological sciences.

Anurans are the largest groups of extant amphibians, comprising of over 6200 species united with a number of derived morphological characteristics which includes: short, tailless bodies (with exception to the larvae form); broad, flat heads with big mouths; and long, muscular hind limb (Deullman and Trueb, 1986; Carroll, 1995; Quicke, 2003; Vitt and Caldwell, 2014).

This body form evolved as an adaptation for saltatory (jumping) movement. The snout-to-vent length (SVL) ranges from 1cm (*Paedophryne amanuensis*) with an average length of 7.7mm to around 32cm (Goliath frog, *Conraua goliath*).

Tree frogs of the family Hylidae are small, semiaquatic vertebrates, whose life span is majorly spent on trees, leaves, slender branches, shrubs and grasses (arboreal adaptation) which includes specialized toe pads for climbing and griping onto surfaces (Schiotz, 1999). They consist of four genera namely; Genus *Leptopelis*, Genus *Afrixalus*, Genus *Hyperolius* and Genus *Kassina.*

Tree frogs are dependent on open waters for their reproduction (e.g. pools, springs, artificial water reservoir with rather warm-climate preference). Their distribution in this relatively arid and topographically variable region is therefore limited by the availability of such habitats. Taking into account their relatively low mobility (apart from possible accidental transport by human; Recuero *et al*., 2007).

The feeding strategy of anurans allows for capturing a wide variety of prey. Their foraging strategies including; sit-and-wait or active feeding, nocturnal and diurnal feeding (Toft, 1980; 1981; Duellman and Trueb, 1986; Simon and Toft, 1991; Lima and Magnusson, 1998; Enabulele and Aisien, 2012). Adult anurans are important predators on invertebrates as they help to balance the population of insects in the ecosystem (Hirai and Matsui, 1999).

Adult tree frogs are insectivores however, as tadpoles, most of them are herbivores (Simon and Toft, 1991). The diet of tree frogs determines the type of parasite and the intensity of the parasite found in the digestive system of the frogs. The environmental condition of the tree frogs also contributes to the type of parasite and the intensity of parasitic infection.

The complex interaction between organisms and their environment has long captured the attention of ecologists and researchers. One such intriguing relationship is the interaction between tree frogs and their food sources within specific habitats. Among the diverse ecosystems, the Okomu Oil Palm Plantation provides a unique setting for investigating the food and feeding habits of tree frogs. As the global significance of biodiversity and ecosystem health becomes more apparent, understanding the dietary preferences and foraging behaviors of these amphibians in such habitats holds implications for both ecological conservation and broader scientific inquiry.

Studies on the diet of arboreal anurans have been undertaken in their natural habitat (Lima *et al.,* 2010; Onadeko, 2011). This investigation in an altered rainforest environment now used for a large scale cultivation of oil palm and rubber is conducted as a result of dearth in information on the dietary composition of tree frogs from the habitat. This has thus necessitated this study to investigate;

- the diet composition and feeding habits of the different species of tree frogs in the okomu oil palm plantation.
- to ascertain the similarities and differences between the size and type of prey taken by the different species of tree frogs.
- describe their feeding habit based on their target prey.
- to compare results with that of other authors from the same ecological zone.

CHAPTER TWO

2.0 LITERATURE REVIEW

Detailed investigation of feeding habits in anurans may help us to understand their ecological significance in a particular habitat.

Labanick, (1976), carried out an investigation on *Acris crepitans* (Cricket frog), comparing food consumed in relation to availability of ground, aquatic and above ground invertebrate preys. Out of the 279 frogs examined, 11 had empty stomachs while the remaining 268 contained 1734 prey items or an average 6.47 items per stomach. It was observed that with increasing frog size, aquatic invertebrates were less preyed upon while the ground invertebrate population were fed on. Rank analysis on the consumption rate of ground prey and above ground preys in relation to availability showed that prey selection was not as important as prey availability as *Acris crepitans* fed on both ground preys (accounting for 45.6% of prey and 20.7% of total volume consumed) and above ground (constituting 33.0% of prey and 38.7% of total volume consumed) while aquatic species accounted for 3.2% of prey and 5% of total amount consumed.

Freed (1980), carried out a laboratory experiment on the prey choice of *Hyla cinerea* (green tree frog) presenting it with five dipteran species; *Aedes aegypti*, *Aedes* taeniorhynchus, and *Anopheles quadrimaculatus*; one large mosquito, *Toxorhynchites rutilus*; and the house fly, *Musca domestica.* House fly, *Musca domestica* which was the most active species was preferred most by the predator *Hyla cinerea,* as exhibited unique behaviours with other species. It shared grooming behaviour (e.g., rubbing the front or rear legs together, or rubbing the rear legs over the wings) with the four mosquito species.

The food and pattern of coexistence of some ecologically similar anuran species (family: Bufonidae, Dendrobatidae, and Leptodactylidae respectively) in a lowland rainforest in the Rio Llullapichis region in Amazonian Peru was investigated by Toft (1980). Thirteen species were collected in 12 areas from different habitats (a stream and a pond) during different seasons (mid-dry season (June and July) mid-wet season (January and February). Majority of the anuran species ate prey different from those found in their habitat except for *Dendrobates femoralis* (Boulenger), which was the only specie that consistently ate preys in proportions that occur in the leaf litter hence classified as generalist feeder. In the designation of specialist and generalist, *Adenomera andreae* and *Eleutherodactylus toftae* were considered non-ant specialist because of their negative electivity of ants and small prey size. The major feeding patterns of the litter anurans were not affected by seasonal change. In the dry season when food abundance goes down, litter anurans were also found to change their feeding behaviour in response to the changing environmental conditions in order to prevent competition for resources e.g *Colostethus marchesianus* changed from a moderate ant specialist (D=0.58) to a generalist in the dry season, taking prey in proportions not significantly different from those in the leaf litter.

Anderson (1993), studied the feeding behaviour of *Rana pipiens* using earthworms (*Lumbricus* sp.) and waxworms (*Galleria* sp.) as prey. *Rana pipiens* exhibited differing behavior patterns depending on the prey it was offered. When feeding on small prey such as waxworms, *R. pipiens* employed tongue protraction to capture prey, reducing the need for extensive head and body movements. However, when feeding on the larger preys such as earthworms, it adopts a body arching posture, lowers it head and uses it jaw to grip prey. In addition, the duration of tongue protraction was significantly longer while feeding on waxworms than while feeding on the earthworms.

Sole and Pelz (2007), conducted a study on the diet of 5 male syntopic hylid species (*Hypsiboas Faber, Dendropsophus minutus, Hypsiboas pufchellus, Scinax granulatus and Scinax perereca*) in Rio Grande do Sul, Brazil to ascertain if they feed during their breeding season. In the study, 50 calling males of each species were collected manually at night at their calling sites with their stomach content flushed and preserved in 70% ethanol for later identification. It was revealed that their stomach content composed of animal prey and plant remains though there were recordings of empty stomachs, *Hypsiboas pulchellus* had about twice more filled stomachs (84%) than those of the other four species (38–48%). Animal prey was most concurrent in the stomach of *Hypsiboas pulchellus* but only rarely in *Hypsiboas faber. Hypsiboas pulchellus* was the only specie with regular intake of animal prey comprising of Coleoptera, larval Lepidoptera and Hymenoptera, while *Dendropsophus minutus* mostly fed on Araneae, Diptera and Homoptera. In addition, Coleoptera and Homoptera were the animal taxa mainly ingested by *Scinax granulatus*, whereas *Scinx perereca* fed on Araneae and Blattaria.

An investigation was conducted by Attademo *et al.*, (2007), in a 10hectare soya bean field of Córdoba province, Argentina to ascertain the diet composition and the relative prey abundance of anurans within the region. Twenty-seven adults of *Physalaemus biligonigerus* (14 females and 13 males) were collected using sixteen pitfall traps with 418 prey items recovered. The prey items recovered composed of 18 prey categories (17 animals and 1 vegetal). The most commonly consumed prey consisted of *Pheidole* sp. (making up 35.17% of the diet, belonging to the order: Hymenoptera; family: Formicidae) and *Armadillium vulgare* (constituting 33.97% of the diet in the order: Isopoda; family: Crustacea). Furthermore, *Armadillium vulgare* was the most abundant in terms of volume (which made up 46.53%), with *Nezara* sp. (constituted

11.81%) and *Anticarsia gemmatalis* (accounted for 11.24%). In general, the diet composition of *Physalaemus biligonigerus* comprised of a higher quantity of mobile arthropods.

An investigation was carried out by Onadeko (2011), on the food and feeding habits of some anuran species in south-western Nigeria (Lagos, Ogun and Oyo state respectively). Eighteen species of anurans were collected of which tree frogs accounted for 27.78% of the total specimens collected. The tree frogs, *Leptopelis hyloides, Hyperolius guttulatus* and *Leptopelis boulengeri* had no Isopterans in their diet which pointed to the fact that these tree frogs do not usually encounter termites as their prey in the arboreal areas. However, high occurrence of hymenopterans such as ants, bees and wasps were recorded.

Abia-Bassey (2011), conducted a survey to determine the dietary composition of 20 *Hoplobatrachus occipitalis* and 40 tree frogs (*Afrixalus dorsalis and Leptopelis hyloides)*. Report on the percentage frequency of prey abundance in the tree frogs pointed that coleopterans were the most frequent prey items, accounting for 45.55% of the total prey consumed. Other prey items comprised of Hymenoptera 36.36%, Diptera 14.55% and orthopteran being the least preyed item 3.64%. In addition, this study revealed that coleopterans were the main dietary preference of *H. occipitalis* and tree frogs.

Fifty-one *Leptopelis hyloides* (42 males and 9 females) were examined for their dietary constituent by Aigbe (2011), in Okomu Oil Palm Plantation, an altered rain forest habitat in Edo State. The prey items recovered were classified into 4 orders: coleopteran, Hymenoptera, Orthoptera and Diptera respectively. Diptera was the least abundant prey accounting for 2% of the prey items consumed compared to Coleoptera which was the most abundant prey item (65.91%). No significant difference ($p>0.05$) was recorded between the feeding rate of both male and female species. The high prey abundances of coleopterans confirmed the description that they may opportunistically feed on other preys but are majorly sit and wait feeders.

An analytical survey was undertaken by Ogbeta (2012), to ascertain the food and feeding habit of 15 species *Afrixalus dorsalis* in a cocoa plantation at Usen, Ovia-South West Local Government Area of

Edo State. Analysis showed that 67% of the total population had full and digested stomach contents, half full stomachs accounted for 20% while 13 % had empty stomach. There was no identifiable prey item recovered from the study, deducing that the *Afrixalus dorsalis* species present at the study area was neither an active forager, a sit and wait or an opportunistic predator.

Marques *et al*. (2019), conducted a study to investigate the feeding ecology of an anuran assembly which composed of six terrestrial frog species (*Elachistocleis cesarii*, *Leptodactylus fuscus*, *Leptodactylus furnarius*, *Leptodactylus latrans, Physalaemus centralis* and *Physalaemus cuvieri*) in a Cerrado protected area to detect if there was a structure in the assemblage based on the specie's diet, in terms of the feeding niche overlap in relation to the species' size. The diet of Elachistocleis cesarii composed mainly of ants, winged termites and termite soldiers; *Leptodactylus fuscus* composed of ants and cockroaches; *Leptodactylus furnarius* was dominated by beetles, winged termites and crickets, while the diet of *Leptodactylus latrans* was composed mainly of beetles, ants and crickets, although one mouse ingested accounted for 21% of the frog relative importance index, due to the prey volume. The diet of *Physalaemus centralis* was dominated by winged termites, ants, and termites (mainly workers), whereas the diet of *Physalaemus cuvieri* was dominated by winged termites, non-reproductive termites (mainly workers), and ants. *Leptodactylus latrans* were considered generalist and opportunistic feeders. They were also found to eat small vertebrates although arthropods constituted their major diet.

Imasuen and Enabulele (2019), studied the prey of two arboreal frogs: *Chiromantis rufescens* (91 males and 8 females) and *Leptopelis spiritusnoctis* (161 males and 37 females) in Okomu national park, Nigeria. The ninety-eight prey items recorded belonged to eight insect orders (Coleopetera 48.98%, Crustacea 1.02%, Dictyoptera 3.06%, Diptyopetra 3.06%, Hymenoptera 19.3%, Isoptera 1.02%, Lepidoptera 2.04% and Orthoptera 18.37%) and a mollusk (Gastropoda 1.02%). Hymenopterans and Coleopterans were the commonest prey taxa categories

in *C. rufescens,* 30.77% and 26.92%, respectively while coleopterans and orthopterans were the commonest prey taxa in *L. spiritusnoctis* 56.94% and 22.22%. frogs with unidentified digested prey items were 102 (*C. rufescens* (30 males and 2 females), *L. spiritusnoctis* (60 males and 10 females)). It was also recorded, 43 *C. rufescens* (38 males and 5 females) and 57 *L. spiritusnoctis* (43 males and 14 females) had empty stomach. In addition, the analyzed stomachs showed that this species of arboreal frogs are not specialist feeders.

Castro ARAÚJO *et al*., (2023), conducted a study on two Adelophryne species (*Adelophryne maranguapensis* and *Adelophryne baturitensis*) found in Ceará state, Northeastern Brazil to describe the diet of both species, measure trophic niche overlap between them, test the relationship between prey size and predator snout-to-vent length and investigate intersexual dietary difference in *A. maranguapensis*. Out of the 117 specimens of *A. maranguapensis* analyzed, 13 individuals (12%) had empty stomachs. Prey items from 58 males and 46 females were identified with Acari and Formicidae being the most frequent and important prey items representing 34.5% and 28.9% of the total number of ingested prey, respectively. In addition, there was no significant variance in respect to prey volume ($H = 2.459$, $p = 0.116$) and prey item consumed by both male and female *A. maranguapensis* ($F = 0.853$, $p = 0.357$). However, there was a positive relationship ($R^2 = 0.089$, $p = 0.001$) between prey volume and frogs' body size. *A. maranguapensis* had more prey diversity (n = 19, Bvol = 4.79) and broader trophic niches compared to *A. baturitensis* (n = 9, Bvol = 2.19) and a substantial overlap in their ecological niches (Øij = 0.67), sharing Formicidae, Acari, Araneae. and not recognizing larval forms as the most important prey items consumed.

The work carried out by the previous researchers, centered on one or two species of tree frogs or generally all anurans. This survey was conducted to ascertain the diet and feeding

behaviour of different arboreal anurans in Okomu oil palm plantation, which is an altered rainforest habitat.

CHAPTER THREE

3.0 MATERIALS AND METHODOLOGY

3.1 DESCRIPTION OF STUDY AREA

The study was carried out within from June to August, 2023 at the Okomu oil palm plantation (Latitude 5°07’ and 5°25*’* E and Longitude 6° 18’ and 6° 26’ N), situated in Ovia South West Local Government Area, Okomu-Udo, Benin City, Edo State, Nigeria. Okomu oil palm plantation is used for the large scale cultivation, processing and marketing of palm oil. It is characterized by two distinct condition of dry and wet seasons with an average annual rainfall of 150mm in the extreme northern part of the state and 250mm close to the coastal area. Temperature remains fairly consistent with average highs of about 30 – 32 ^{o}C and average lows of 22 – 24^{o}C. In addition, his rain forest is characterized by tall trees, dense undergrowth and a wide variety of plant species including hard woods like Iroko, mahogany and also various type of palms, lianas and ferns.

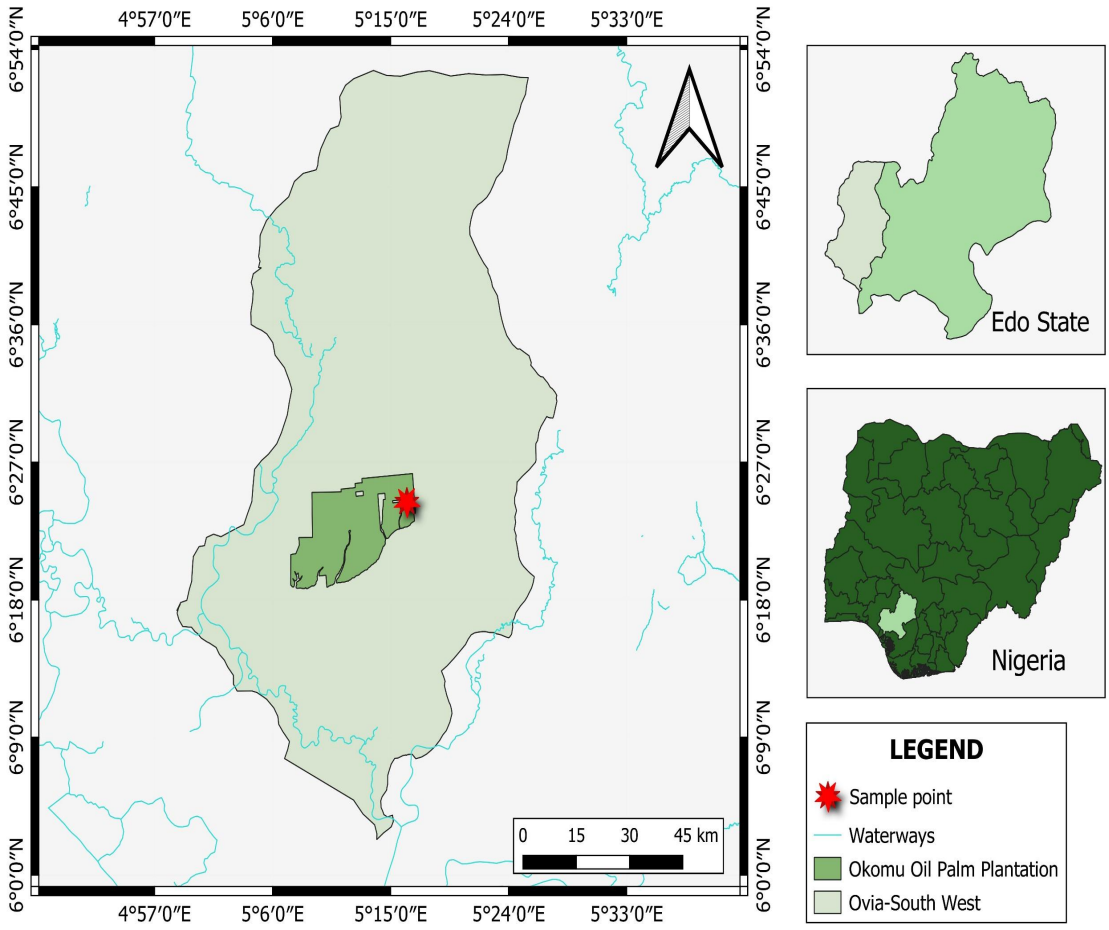

Figure 3. 1: Map of Edo state, showing the study area (Okomu in Ovia South Local Government Area.).

3.2 METHODOLOGY

3.2.1 Sampling method

Different species of tree frogs were collected by hand from different locations within the Okomu Oil Palm Company (Okomu GH, Okomu oil palm, and Okomu oil mill). Amphibians were collected between the hours of 19:00 hours to 23:00 hours using the Acoustic Encounter Survey (AES) and the Visual Encounter Survey (VES) techniques to estimate the density of amphibians in each sampling site. Acoustic encounter survey was carried out by listening to the advertisement calls of the male frog and identifying the direction from which the sound is coming from (this increases chances of locating the frog). It is also necessary to have a powerful flash ligh was used to make visualization easy. When approaching the collection point, of the audio located amphibian, it is advisable to turn off your flashlight and turn it back on when at the location as the frogs are caught up by an element of surprise and are easily collected and put in a perforated plastic bottle pending anesthetic.

3.2.2 Euthanization of Amphibians

Captured specimens were transported back to base camp where they were euthanized with benzocaine solution and further injected and fixed with 5% formalin to arrest digestion.

3.2.3 Identification and measurement

Specimens were identified according to the protocol of Rodel (2000) which involved the examination of external morphology. The males were identified externally by the presence of vocal sac, nuptial spines and internally by the presence of gonads. The snout-to-vent length (SVL) of the frogs were measure individually with vernier calipers to the nearest centimeter.

3.2.4 Examination of samples for stomach content

Prior to examining of the stomach contents, the amphibians were washed free of 5% formalin by washing it overnight under running water. The amphibians were thereafter dissected (longitudinal abdominal incision) and the stomach removed and placed in a Petri dish containing distilled water. Stomach was slit open with the aid of a dissecting pin and their contents examined under a dissecting microscope (Nikon SMZ 645 Dissecting Microscope) at X10 magnification. The stomachs were grouped as empty or with diet (either as identifiable items or digested content).

3.2.5 Data analysis

Chi-square analysis was used to ascertain the difference in the number of tree frog's species investigated.

3.2.6 Prey item Analysis

The rate of feeding activity was estimated as the percentage of stomachs containing food with respect to the total number of stomachs examined. (Sala and Ballesteros, 1997).

$$\text{Rate of feeding} = \frac{r \times 100}{R}$$

r = total number of stomachs with food

R= total number of stomachs examined

Statistical analysis of variance (ANOVA) was used to analyze the differences in the dietary content of the anuran species. All analysis was done using Microsoft Excel.

CHAPTER FOUR

4.0 RESULTS

A total of 76 tree frogs (72 males and 4 females) belonging to one family (Hyperolidae), two genera (*Afrixalus* and *Hyperolius*) and five species were examined in this study. The species examined included *Afrixalus dorsalis*, *Hyperolius concolor*, *H. fusciventris, H. fusciventris burtoni,* and *H. picturatus* (Plates 4.1 (a-e)). *Afrixalus dorsalis* accounted for 44.74% (32 males and 2 females), *Hyperolius concolor* accounted for 34.21% (25 males and 1 female), *H. fusciventris burtoni* 11.84% (9 males), *H. fusciventris*, 7.89% (5 males and 1 female) and *Hyperolius picturatus*, 1.32% (1 male) of the entire collection (Table 4.1). The mean snout-to-vent length and range of the tree frogs are shown in (Table 4.2) respectively. More males than females were collected (Figure 4.1).

Of the 76 collected individuals, 20 had empty stomach, 23 had their stomach full while 33 had food materials at an advanced stage of digestion. A total of 24 prey items were recovered and they belonged to 5 different categories. Eight prey items could not be unidentified. The identified items were members of: Hymenoptera, Diptera, Coleoptera, Aranida and Orthoptera.

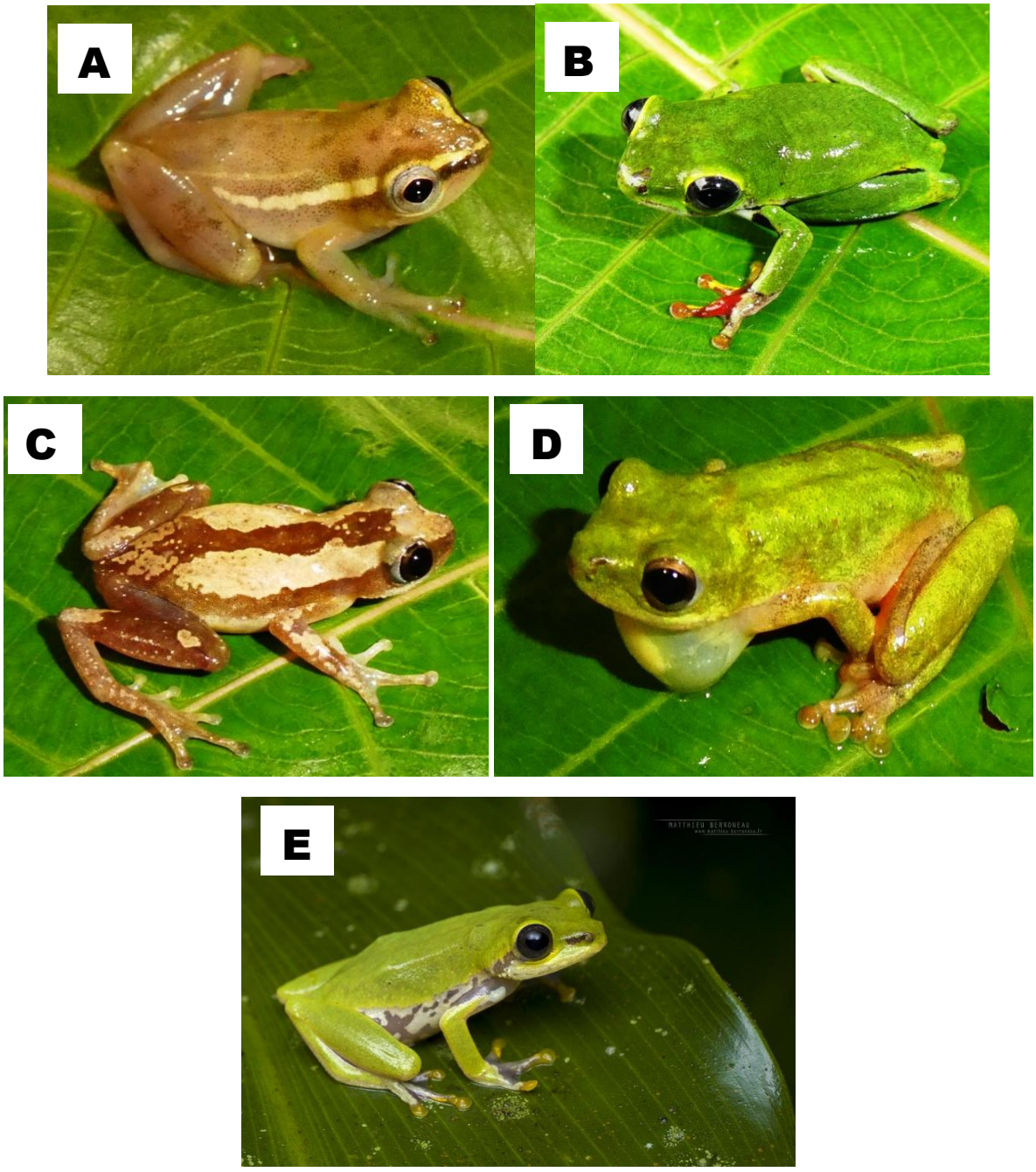

Plate 4. 1: (a - e) Species of arboreal anurans collected.

(a) *Hyperolius picturatus* (b) *Hyperolius fusciventris burtoni* (c) *Afrixalus dorsalis*

(d) *Hyperolius concolor* (e) *Hyperolius fusciventris* (Matthieu Barroneau, 2021)

Table 4. 1: Sexes of the species and their percentage abundance

Species	**Male**	**Female**	**Total**	**Abundance (%)**
Afrixalus dorsalis	32	2	34	44.74%
Hyperolius concolor	25	1	26	34.21%
Hyperolius fusciventris burtoni	9	0	9	11.84%
Hyperolius fusciventris	5	1	6	7.89%
Hyperolius picturatus	1	0	1	1.32%

Table 4. 2: showing the mean snout-to-vent length arboreal anurans collected in the Okomu oil Palm Plantation.

ANURANS	MALE		FEMALE	
	Mean ± SD	**Range**	**Mean ± SD**	**Range**
Afrixalus dorsalis	2.48 ± 0.17	2.10 - 2.90	2.7 ± 0.1	2.6- 2.8
Hyperolius concolor	2.39 ± 0.47	1.60 - 3.0	3.5	-
Hyperolius fusciventris burtoni	1.96 ± 0.10	1.80 - 2.10	-	-
Hyperolius fusciventris	2.44 ± 0.52	1.70 - 2.90	3.2	-
Hyperolius picturatus	2.0	-	-	-

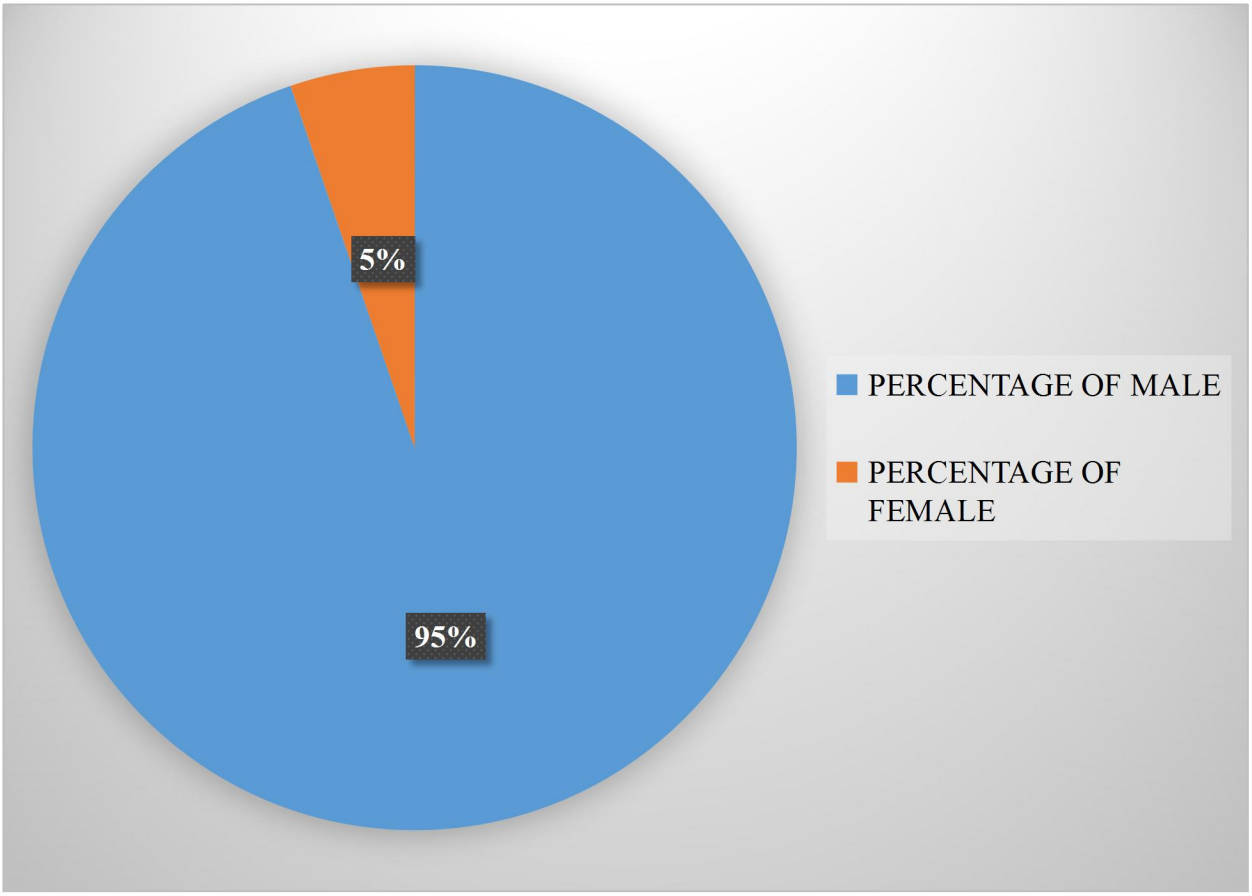

Figure 4. 1: Percentage distribution of male female tree frogs examined

Prey items found in the stomach of *Afrixalus dorsalis* comprised of Dipterans (3), Coleopteran (2), Araneida (2), unidentified prey items (3) as well as digested prey items (14). In *Hyperolius concolor*, the recovered items included Hymenoptera (9), Diptera (2), Orthoptera (1), 5 unidentified prey items and (10) digested preys; *Hyperolius fusciventris* had Hymenoptera (1), Coleoptera (2) and digested preys (4); *Hyperolius fusciventris burtoni* ingested Hymenoptera (1), Araneida (1) and digested prey (4), while the prey item in the only *Hyperolius picturatus* caught was fully digested (Table 4.4).

The percentage frequency (%F) of occurrence of overall prey items recovered from the stomach content of the tree frogs are shown in (Table 4.3 and Figure 4.2). Hymenoptera was a common diet among *Hyperolius* species, occurring mostly in *H. concolor* (75%). Dipterans constituted 42.86% of the total prey ingested by *Afrixalus dorsalis* while coleopteran and Araneida both accounted for 28.57% (Table 4.5).

The rate of feeding for the anuran species were: *Afrixalus dorsalis* (68%), *Hyperolius fusciventris burtoni* (67%) and *Hyperolius concolor* (81%). Statistical analysis of variance (ANOVA) showed that there was no significant difference ($p>0.05$) in the rate of feeding of all species examined.

Table 4. 3: Frequency of occurrence and percentage frequency of the overall stomach content of tree frogs examined.

STOMACH CONTENT	FO	%FO
Hymenoptera	11	16.92%
Diptera	5	7.69%
Coleoptera	4	6.15%
Spider	3	4.62%
Orthoptera	1	1.54%
Digested	33	50.77%
Unidentified	8	12.31%

Table 4. 4: Diet of anurans from the Okomu oil Palm Plantation, showing the occurrence of different prey items found in the stomach

	Anuran hosts				
Prey items	*Afrixalus dorsalis* (n=34)	*Hyperolius concolor* (n=26)	*Hyperolius fusciventris* (n=6)	*Hyperolius picturatus* (n=1)	*Hyperolius fusciventris burtoni* (n=9)
Hymenoptera	0	9	1	0	1
Diptera	3	2	0	0	0
Coleoptera	2	0	2	0	0
Spider	2	0	0	0	1
Digested content	14	10	4	1	4
Unidentified	3	5	0	0	0
Orthoptera	0	1	0	0	0

Table 4. 5: Percentage frequencies (%FO) of prey items recovered in the arboreal anurans from Okomu oil palm plantation.

	ANURANS							
Food items	*Afrixalus dorsalis*		*Hyperolius concolor*		*Hyperolius fusciventris*		*Hyperolius fusciventris burtoni*	
	No of prey items	%FO	No of prey items	%FO	No of prey items	%FO	No of prey items	%FO
Hymenoptera	0	0	9	75.00	1	33.33	1	50.00
Diptera	3	42.86	2	16.67	0	0.00	0	0.00
Coleoptera	2	28.57	0	0.00	2	66.67	0	0.00
Araneida	2	28.57	0	0.00	0	0.00	1	50.00
Orthoptera	0	0	1	8.33	0	0.00	0	0.00
Total	**7**		**12**		**3**		**2**	

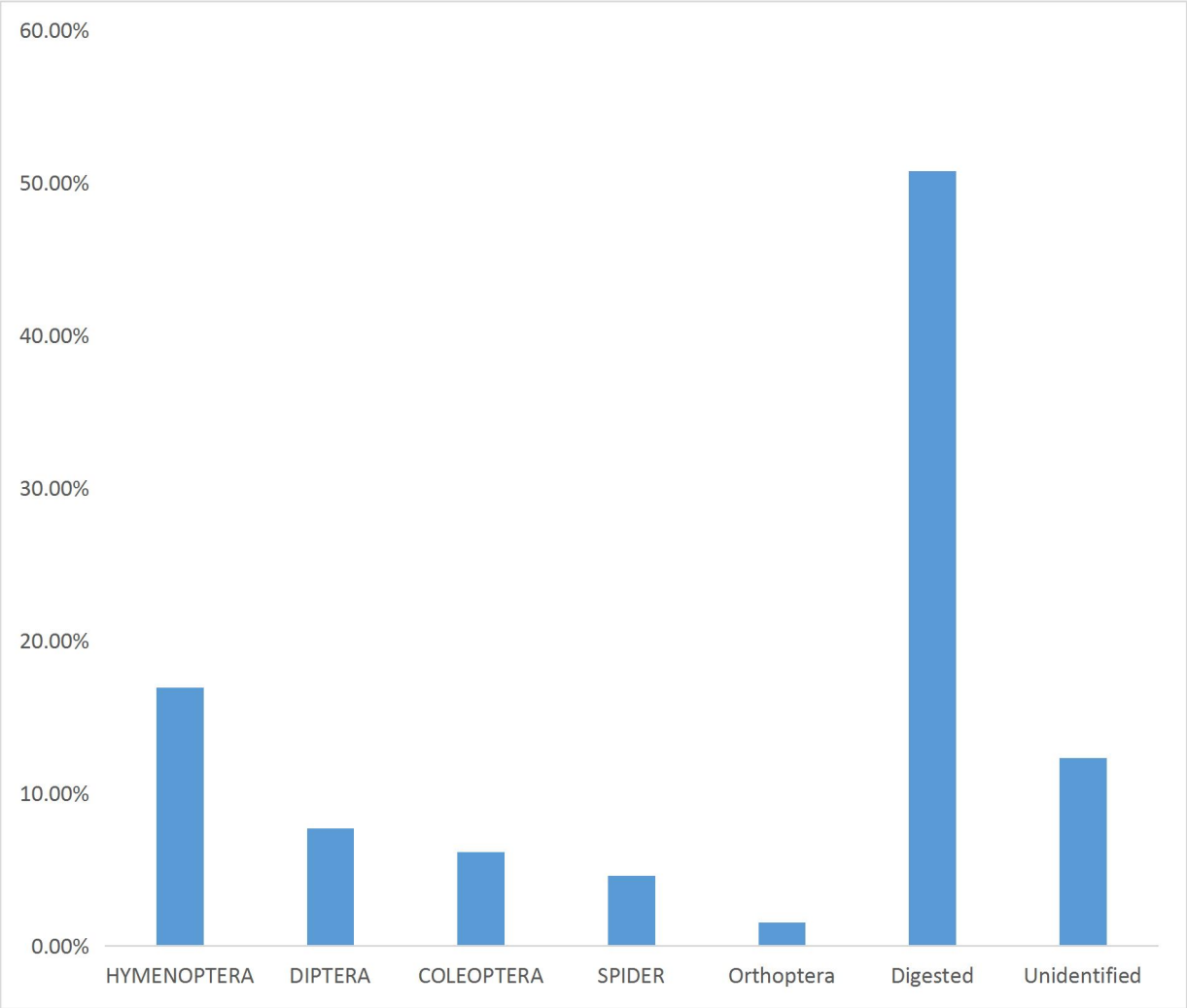

Figure 4. 2: A bar graph showing the stomach content of all tree frogs

CHAPTER FIVE

5.0 DISCUSSION

In the course of investigation, 76 tree frogs were captured, (72 males and 4 females). The collected specimens included *Afrixalus dorsalis* and several *Hyperolius* species, including *H. concolor, H. fusciventris, H. fusciventris burtoni,* and *H. picturatus*. Notably, *A. dorsalis* was the most abundant species, accounting for 44.74% of the total population.

It is note-worthy that more males than females were collected in this study. This gender disparity can be attributed to the fact that males are typically vocal and exposed than females, making them readily available to be located and captured. The study carried out by Aigbe (2011) on the dietary constituent of 51 *Leptopelis hyloides* in Okomu Oil Palm Plantation showed similar gender disparity as 42 males were collected and 9 females. Imasuen and Enabulele (2019) in the study of 2 arboreal tree frogs, *Chiromantis rufescens* and *Leptopelis spiritusnoctis* in the Okomu national park, Nigeria also recorded (91 males and 8 females) and (161 males and 37 females). The study conducted by Attademo *et al.*, (2007), in a 10hectare soya bean field of Córdoba province, Argentina to ascertain the diet composition and the relative prey abundance of 27 of *Physalaemus biligonigerus* showed contrast as females were higher than male (14 females and 13 males).

Analysis of the diet composition of the tree frogs revealed little diversity in terms of the food items consumed by them in Okomu Oil Palm Plantation. Hymenoptera, Orthoptera, Araneida, Diptera and Coloeptera constituted the diets of these frogs (Table 4.3). This is similar to the investigation carried out by Lima *et al.,* (2010) on the diet of the two sympatric species of leaf frogs, *Phyllomedusa rhodei and Phyllomedusa burmeisteri* in a cocoa plantation in southern Bahia, Brazil. They were reported to comprise of Hymenoptera, Orthoptera, Diptera and Coloeptera. Similar prey items (Hymenoptera, Orthoptera, Diptera and Coloeptera) were also reported in *Leptopelis hyaloides* in the study conducted by Enabulele and Aisien (2012) at the Okomu Oil Palm and Rubber Plantations. This indicated that the diets

of the frogs in the plantations are a reflection of food item available in the plantation rather than selective mode of feeding.

Also, we examined their stomach contents and categorized the feeding behavior based on the status of their stomachs. We found that 20 individuals had empty stomachs, 23 had full stomachs, and 33 had digested food material. This indicates that the tree frogs were actively feeding as at the period they were collected. A survey carried out by Gbeta (2012) on *Afrixalus dorsalis* showed no identifiable prey item as most of the food materials were already digested. It seems tree frogs have a fast rate of food digestion as it was similarly observed that the prey items in many frogs (33 frogs) were unidentifiable as these were already digested.

Notably, Hymenoptera (ants) were a common dietary choice among *Hyperolius* spp., with *H. concolor* exhibiting a particularly strong preference for this category, representing 75% of its diet. Ants are mostly nocturnal and their abundance coincides with the feeding regime of the tree frogs. Diptera, on the other hand, constituted a significant portion (42.86%) of the total prey ingested by *Afrixalus dorsalis*, highlighting interspecies differences feeding habits. The large occurrence of dipterans in the diet of *A. dorsalis* showed that they were more efficient in the capture of dipterans as also observed by Galati (1992) and Toft (1981,1995).

The percentage frequency (%F) of occurrence of prey items revealed intriguing dietary preferences among the tree frogs. Hymenoptera made up 16.67% of the total prey items ingested, with Diptera (7.58%) and Coleoptera (6.06%) following suit. Araneida (4.55%) and Orthoptera (1.52%) were also present but to a lesser extent.

CONCLUSION

This study has provided valuable insights into the dietary preferences and feeding habits of tree frogs at Okomu Oil Palm Plantation. The varying dietary preferences observed highlight the ecological complexity of these amphibians and their potential roles in shaping local ecosystems. Further research on the ecological consequences of these feeding habits and potential implications for prey populations is suggested. This investigation has contributed to the understanding of amphibian ecology and underscores the importance of preserving the diverse habitats that support these fascinating creatures.

REFERENCES

Abia-Bassey, Y.A., (2011). *Food and feeding habits of Hoplobatrachus occipitalis and tree frogs of Obazuwa lake in Benin City.* (B.Sc. Thesis. University of Benin)

Aigbe, E., (2011). *Dietary constituent of Leptopelis hyloides in Okomu Oil Palm Plantation in Ovia South, Edo state*. (B.Sc. Thesis. University of Benin).

Anderson, C. W. (1991). The modulation of feeding behavior in response to visual stimuli in *Rana pipiens*. *Arizona-Nevada Academy of Science*, **26**: 14.

Anderson, C. W. (1993). The modulation of feeding behavior in response to prey type in the frog *Rana pipiens*. *Journal of Experimental Biology*, **179**(1): 1-12.

Anderson, C. W., and Nishikawa, K. C. (1993). A prey-type dependent hypoglossal feedback system in the frog *Rana pipiens*. *Brain, behavior and evolution*, **42**(3): 189-196.

Anderson, C. W., and Nishikawa, K. C. (1996). The roles of visual and proprioceptive information during motor program choice in frogs. *Journal of Comparative Physiology A*, **179**: 753-762.

Attademo, A. M., Peltzer, P., and Lajmanovich, R. C. (2007). Feeding habits of Physalaemus biligonigerus (Anura, Leptodactylidae) from soybean field of Córdoba Province, Argentina.

Barbosa, A. S., de Oliveira, M., Leal, A. L., Von Mühlen, C., Spindler, C. S., and Solé, M. (2014). Diet of *Hypsiboas leptolineatus* (Braun and Braun, 1977) (Amphibia: Anura: Hylidae) during the breeding season. *Herpetology Notes*, **7**: 505-508.

Blackith, R. M., and Speight, M. C. D. (1974). Food and feeding habits of the frog Rana temporaria in bogland habitats in the West of Ireland. *Journal of Zoology*, **172**(1): 67-79.

Cassiano-Lima, D., Borges-Nojosa, D. M., Cascon, P., and Cechin, S. Z. (2011). The reproductive mode of *Adelophryne maranguapensis* Hoogmoed, Borges and Cascon, 1994,(Anura, Eleutherodactylidae) an endemic and threatened species from Atlantic Forest remnants in northern Brazil. *North-Western Journal of Zoology*, **7**(1).

Castro Araújo, K., Cassiano-Lima, D., Carolina Brasileiro, A., Holanda Bezerra, C., and Waldemar Ávila, R. (2023). What the minute shield frogs Adelophryne eat at a humid forest relict in Ceará state, northeastern Brazil. *North-Western Journal of Zoology*, 19(1).

Da Silva, H. R., de Britto-Pereira, M. C., and Caramaschi, U. (1989). Frugivory and seed dispersal by Hyla truncata, a neotropical treefrog. *Copeia*, **1989**(3): 781-783.

Deban, S. M., and Nishikawa, K. C. (1992). The kinematics of prey capture and the mechanism of tongue protraction in the green tree frog Hyla cinerea. *Journal of experimental biology*, **170**(1): 235-256.

Drewes, R. C. (2000). Treefrogs of Africa.

Duellman, W.E., and Trueb, L. (1994). *Biology of amphibians.* JHU press.

De Paula Lima, J. E., Roedder, D., and Sole, M. (2010). Diet of two sympatric Phyllomedusa (Anura: Hylidae) species from a cacao plantation in southern Bahia, Brazil. *North-Western Journal of Zoology*, *6*(1).

Enabulele, E. E., and Aisien, M. S. O. (2012). Diets of *Hemisus mamoratus* and *Leptopelis hyloides* (order anura) from monoculture plantations in southern Nigeria. *Zoologist*, **10**:48-52.

Estabrook, G. F., and Dunham, A. E. (1976). Optimal diet as a function of absolute abundance, relative abundance, and relative value of available prey. *The American Naturalist*, **110**(973): 401-413.

Freed, A. N. (1980). Prey selection and feeding behavior of the green tree frog (*Hyla cinerea*). Ecology, **61**(3): 461-465.

Hirai, T., and Matsui, M. (1999). Feeding habits of the pond frog, *Rana nigromaculata,* inhabiting rice fields in kyoto, japan, *Copeia*, **1999(4)**: 940 – 947

Houston, W. W. K. (1973). The food of the common frog, *Rana temporaria*, on high moorland in northern England. *Journal of Zoology*, **171**(2): 153-165.

Imasuen, A. A., and Enabulele, E. E. (2019). Preys of Two Arboreal Frogs: *Chiromantis rufescens* and *Leptopelis spiritusnoctis* in Okomu National Park, Nigeria. *African Scientist,* **20**(1).

Johnson, B. K., and J. L. Christiansen. 1976. The food and food habits of Blanchard's cricket frog, Acris crepitans blanchardi (Amphibia, Anura, Hylidae), in Iowa. *Journal of Herpetology* **10**:63-74.

Kouamé, N. G., C. Ofori-Boateng, G. B. Adum, G. Gourène, and M. O. Rödel. "The anuran fauna of a West African urban area." *Amphibian and Reptile Conservation* 9, no. 2 (2015): 1-14.

Labanick, G. M. (1976). Prey availability, consumption and selection in the cricket frog, *Acris crepitans* (Amphibia, Anura, Hylidae). *Journal of Herpetology*, 293-298.

Mahan, R. D., and Johnson, J. R. (2005). Diet of the gray treefrog (*Hyla versicolor*) in relation to foraging site characteristics, with comments on stomach-flushing technique. *Multi-scale Investigations of Gray Treefrog Movements: Patterns of Migration, Dispersal, and Gene Flow*, 219.

Mahan, R. D., and Johnson, J. R. (2007). Diet of the gray treefrog (*Hyla versicolor*) in relation to foraging site location. *Journal of Herpetology*, **41**(1):16-23.

Maneyro, R., and Da Rosa, I. (2004). Temporal and spatial changes in the diet of Hyla pulchella (Anura, Hylidae) in southern Uruguay. *Phyllomedusa: Journal of Herpetology*, **3**(2): 101-103.

Marques-Pinto, T., Barreto-Lima, A. F., and Brandao, R. A. (2019). Dietary resource use by an assemblage of terrestrial frogs from the Brazilian Cerrado. *North-Western Journal of Zoology*, **15**(2).

Monroy, J. A., and Nishikawa, K. (2011). Prey capture in frogs: alternative strategies, biomechanical trade‐offs, and hierarchical decision making. *Journal of Experimental Zoology Part A: Ecological Genetics and Physiology*, **315**(2): 61-71.

Monroy, J. A., and Nishikawa, K. C. (2009). Prey location, biomechanical constraints, and motor program choice during prey capture in the tomato frog, *Dyscophus guineti*. *Journal of Comparative Physiology* A, **195**(9): 843–852.

Ogbeta, I.K., (2012). *Food and feeding habits of Afrixalus dorsalis in cocoa plantation at usen, ovia south west local government area of Edo state, Benin City, Nigeria*. (B.Sc. Thesis. University of Benin).

Onadeko A.B., (2011). Food and feeding habits of some anuran species in south-western Nigeria. *Zoologist (The).* **9**:57-69.

Oplinger, C. S. 1976. Food habits and feeding activity of recently transformed and adult *Hyla crucifer crucifer*. *Herpetologica* **23**:209-217.

Ritter, D., and Nishikawa, K. (1995). The kinematics and mechanism of prey capture in the African pig-nosed frog (Hemisus marmoratum): description of a radically divergent anuran tongue. *Journal of experimental biology*, **198**(9): 2025-2040.

Solé, M., and Pelz, B. (2007). Do male tree frogs feed during the breeding season? Stomach flushing of five syntopic hylid species in Rio Grande do Sul, Brazil1. *Journal of Natural History,* **41**(41-44): 2757–2763.

Sole, M., Ketterl, J., Di-bernardo, M., and Kwet, A. (2002). Ants and termites are the diet of the microhylid frog Elachistocleis ovalis (Schneider, 1799) at an Araucaria forest in Rio Grande do Sul, Brazil. *Herpetological Bulletin*, (79): 14-17.

Stebbins, R. C., and Cohen, N. W. (1997). *A Natural History of Amphibians*. Princeton University Press.

Toft, C. A. (1980). Feeding ecology of thirteen syntopic species of anurans in a seasonal tropical environment. *Oecologia*, **45**: 131-141.

Turner, F. B. (1959). An analysis of the feeding habits of Rana p. pretiosa in Yellowstone Park, Wyoming. *The American Midland Naturalist*, **61**(2): 403-413.

Vera Candioti, M. F., Lavilla, E. O., and Echeverría, D. D. (2004). Feeding mechanisms in two treefrogs, Hyla nana and Scinax nasicus (Anura: Hylidae). *Journal of Morphology*, **261**(2): 206-224.

Wells, K. D. (2010). *The Ecology and Behavior of Amphibians*. University of Chicago Press.

Woolbright, L. L. (1985). Aggressive and courtship calls of the treefrogs Hyla cinerea and Hyla gratiosa. *Copeia*, **1985**(2): 366-372.

Zug, G. R. and Duellman,W.E., (2022, March 7). *frog and toad*. *Encyclopedia Britannica*. https://www.britannica.com/animal/Anura

APPENDIX 1.

Diet composition of Male and Female species of *Afrixalus dorsalis, Hyperolius Concolor, Hyperolius Fusciventris, Hyperolius Picturatus* and *Hyperolius fusciventris burtoni).*

M = Male

F = Female

SVL = Snout Vent Length

S/N	SPECIES	SEX	SVL (cm)	STOMACH CONTENT
1	*Afrixalus dorsalis*	M	2.8	Empty Stomach
2	*Afrixalus dorsalis*	F	2.8	1 Unidentified
3	*Afrixalus dorsalis*	M	2.5	Empty Stomach
4	*Afrixalus dorsalis*	M	2.5	Empty Stomach
5	*Hyperolius concolor*	M	3.0	1 Diptera
6	*Hyperolius concolor*	M	2.9	Digested
7	*Afrixalus dorsalis*	M	2.3	Empty Stomach
8	*Hyperolius concolor*	M	2.7	Empty Stomach
9	*Afrixalus dorsalis*	M	2.6	Digested
10	*Hyperolius concolor*	M	2.8	Digested
11	*Afrixalus dorsalis*	M	2.7	Empty Stomach
12	*Hyperolius concolor*	M	2.8	Digested
13	*Hyperolius concolor*	M	2.9	Digested
14	*Hyperolius concolor*	M	2.8	3 Hymenoptera (ant)
15	*Afrixalus dorsalis*	M	2.4	Digested
16	*Afrixalus dorsalis*	M	2.4	Digested
17	*Hyperolius concolor*	M	2.1	1 Hymenoptera
18	*Afrixalus dorsalis*	M	2.5	Empty Stomach
19	*Afrixalus dorsalis*	M	2.6	Empty Stomach
20	*Hyperolius concolor*	M	2.8	Empty Stomach
21	*Afrixalus dorsalis*	M	2.2	Empty Stomach
22	*Afrixalus dorsalis*	M	2.2	Empty Stomach

23	*Afrixalus dorsalis*	M	2.5	Empty Stomach
24	*Afrixalus dorsalis*	M	2.6	Empty Stomach
25	*Hyperolius concolor*	M	2.8	Empty Stomach
26	*Afrixalus dorsalis*	M	2.6	Digested
27	*Hyperolius fusciventris*	M	2.7	Digested
28	*Afrixalus dorsalis*	M	2.5	Digested
29	*Afrixalus dorsalis*	M	2.5	Digested
30	*Hyperolius concolor*	M	1.8	Empty Stomach
31	*Afrixalus dorsalis*	M	2.4	Digested
32	*Afrixalus dorsalis*	M	2.6	1 Not Identified
33	*Hyperolius fusciventris*	M	2.1	Digested
34	*Afrixalus dorsalis*	M	2.4	Empty Stomach
35	*Hyperolius concolor*	M	1.8	Not Identified
36	*Afrixalus dorsalis*	M	2.7	Not Identified
37	*Hyperolius concolor*	M	2.9	Orthoptera
38	*Afrixalus dorsalis*	M	2.1	Digested
39	*Afrixalus dorsalis*	M	2.9	Digested
40	*Afrixalus dorsalis*	M	2.5	2 Coleoptera (beetle)
41	*H. fusciventris*	M	2.9	2 Coleoptera (beetle)
42	*Afrixalus dorsalis*	M	2.4	Digested
43	*Hyperolius concolor*	M	2.9	Digested
44	*Hyperolius concolor*	M	2.4	Empty Stomach
45	*Hyperolius fusciventris burtoni*	M	2.1	Empty Stomach
46	*Hyperolius fusciventris burtoni*	M	2.1	Digested
47	*Afrixalus dorsalis*	M	2.3	Diptera
48	*Hyperolius fusciventris*	F	3.2	Digested
49	*Hyperolius concolor*	F	3.5	Digested
50	*Hyperolius fusciventris burtoni*	M	1.9	Digested
51	*Hyperolius fusciventris*	M	2.8	Digested
52	*Afrixalus dorsalis*	M	2.4	Digested
53	*Afrixalus dorsalis*	F	2.6	1 Araneida

54	*Afrixalus dorsalis*	M	2.6	1 Diptera
55	*Afrixalus dorsalis*	M	2.5	Digested
56	*Afrixalus dorsalis*	M	2.5	Digested
57	*Hyperolius picturatus*	M	2.0	Digested
58	*Hyperolius fusciventris burtoni*	M	2.0	Empty Stomach
59	*Hyperolius fusciventris burtoni*	M	1.9	1 Hymenoptera (ant)
60	*Afrixalus dorsalis*	M	2.3	1 Diptera
61	*Hyperolius concolor*	M	1.9	Not Identified
62	*Hyperolius concolor*	M	1.8	Not Identified
63	*Hyperolius concolor*	M	1.8	5 Hymenoptera (ant)
64	*Hyperolius concolor*	M	2.7	Not Identified
65	*Afrixalus dorsalis*	M	2.3	1 Araneida
66	*Hyperolius concolor*	M	2.1	Digested
67	*Hyperolius fusciventris burtoni*	M	1.9	Digested
68	*Hyperolius fusciventris burtoni*	M	1.9	Digested
69	*hyperolius concolor*	M	2.5	Digested
70	*Hyperolius fusciventris burtoni*	M	1.8	1 Araneida
71	*h. fusciventris*	M	1.7	1 Hymenoptera (ant)
72	*Hyperolius fusciventris burtoni*	M	2.0	Empty Stomach
73	*Hyperolius concolor*	M	2.0	Digested
74	*Hyperolius concolor*	M	2.0	Digested
75	*Hyperolius concolor*	M	1.9	1 Not Identified
76	*Hyperolius concolor*	M	1.6	1 Diptera